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ABSTRACT

Background: Choose to Move (CTM) is one of few scaled-up health-promoting interventions for older adults. We evaluated whether CTM participants maintained their intervention-related gains in physical activity (PA), mobility and social connectedness 12 months after the intervention ended.

Methods: We assessed PA, mobility, loneliness, social isolation and muscle strength via questionnaire and objective measures in 235 older adults at baseline, 6-months (end of intervention) and 18-months (12-months post-intervention). We fitted linear mixed models to examine change in each outcome from 6 to 18 months (primary objective) and 0 to 18 months (secondary objective) and report by age group (60-74; 75+ yrs).

Results: In younger participants, PA decreased between 6- and 18-months but remained significantly higher than at baseline. Intervention-related benefits in loneliness, social isolation, mobility and muscle strength were maintained between 6 and 18 months in younger participants. Older participants maintained their intervention benefits in loneliness, mobility and muscle strength. When compared with baseline, PA levels in older participants were unchanged whereas social isolation increased.

Conclusions: Older adults maintained some, but not all, health benefits of CTM 12 months after the intervention ended. Long-term commitments are needed to deliver effective health-promoting interventions for older adults--if benefits are to be maintained.

BACKGROUND

Population aging worldwide [1] intersects with older adults' low levels of physical activity (PA) [2, 3] and increased prevalence of chronic diseases [4] to create a 'perfect storm'. Thus, active aging is a public health priority [5]. Although many interventions effectively increased older adults' PA [6], most focussed on short-term behaviour change (i.e., immediately post-intervention). To achieve longer-term health benefits, positive health behaviours must be maintained–defined as behaviours that persist for a minimum of six months after initial behaviour change [7]. Maintenance is particularly important for older adults who otherwise experience age-related declines in PA [8, 9] and mobility [10]. A recent systematic review [6] noted that of 14 older adult PA interventions, only 3 had a follow-up period of 1 year or longer [11, 12]. This prompted a call from authors of a systematic review of reviews [13] for more PA intervention studies with longer follow-up periods.

To enhance population health, effective interventions must be scaled-up to reach greater numbers of individuals [14]. Over 400 studies of PA interventions in older adults were published since 1990, yet only 6 of them [11, 15-19] were scaled-up and evaluated [20]. Of these, only two studies assessed whether PA behaviour change was maintained [11]. In the PACE-UP and PACE-Lift trials, adults aged 45-75 years participated in a 12-week pedometer-based walking intervention. Those in the walking group maintained higher levels of moderate to vigorous PA (by accelerometry) compared with adults in the control group 3 to 4 years after the intervention ended. Among the many reasons few effective interventions are scaled-up and sustained are the resources required to do so, shifting priorities among funding partners, public interest and lack of political will [21, 22].

Choose to Move (CTM) is a scalable, 6-month PA intervention targeting low physically active (<150 min/week) older adults [23-26]. CTM is being scaled up in a phased approach across British Columbia, Canada. The 6-month CTM intervention enhanced PA, mobility and social connectedness (i.e., decreased feelings of loneliness and social isolation) among older adult participants aged 60 years and older [23]. In this study we followed up these participants 12 months after the intervention ceased (18 months after participants began the intervention). Our primary objective was to assess whether participant-level outcomes were maintained in the year following CTM (from 6 to 18 months). We define maintenance of the intervention benefit as no statistically significant difference between measures taken at 6 and 18 months. We hypothesized that intervention-related benefits in PA, social connectedness (loneliness, social isolation), mobility and muscle strength would not be maintained 12 months after completing CTM. Our secondary objective was to report whether participant-level outcomes at 18 months differed from baseline (pre-intervention) values. We hypothesized that outcomes would return to baseline such that values at 18 months would be similar to values at baseline. As in a previous analysis [23], we planned (a priori) to split the cohort by age (60-74 years and ≥75 years) to assess change by age group.

METHODS

Choose to Move

Choose to Move is not prescriptive but was designed based on evidence [16], as an adaptable model whereby participants *choose* what they enjoy and are able to do. At the organization level CTM builds community capacity to support awareness of, and access to, local health promoting opportunities. At the individual (participant) level CTM activity coaches provided personalized support to create PA action plans customized to each individual's activity preferences, resources and mobility capacity. CTM also addressed barriers to PA, provided opportunities for social support and to share and learn with fellow participants. During the 6-month intervention, trained activity coaches from two community-based delivery partner organizations (Young Men's Christian Association [YMCA]; British Columbia Parks and Recreation Association [BCRPA])) provided participants with: 1) a 60-minute one-on-one consultation, 2) 4 motivational group meetings (up to 12 participants/group), and 3) 10 telephone check-ins. Activity coaches provided more support during the first 3 months (one-on-one meeting, 7 telephone calls, 4 group meetings) compared to the last 3 months (3 telephone calls) (Figure 1).

Study design and participants

Conceptual frameworks for implementation and evaluation, guiding principles, the intervention and evaluation methods are described in detail elsewhere [23-25]. Briefly, we used a type 2 hybrid effectiveness-implementation study design [27] to evaluate CTM. We previously reported outcomes measured at 0 (baseline), 3 (mid-intervention) and 6 (post-intervention) months [23]. The current study presents our findings 1 year after the intervention ceased (18 months from baseline). The University of British Columbia and Simon Fraser University Clinical Research Ethics Boards (H15-02522 [UBC] and 22015s0614 [SFU]) approved all study procedures.

Together, delivery partners reached small (n=8), medium (n=7) and large (n=11) urban communities across British Columbia. Delivery partner organizations recruited participants using a variety of strategies (e.g., local promotions such as program guides, posters, and information sessions; media advertisements; and word of mouth). Eligible participants were community-dwelling men and women aged ≥60 years, English speaking, and physically inactive (self-reported <150 minutes/week of PA) with no contra-indications to PA participation (Physical Activity Readiness-Questionnaire+ [28] or physician clearance). We trained delivery partners to describe the evaluation to registered participants and invite them to participate. Of 534 participants across 56 programs delivered between January 2016 and May 2017, 458 (86%) older adults consented to participate in the evaluation (province-wide assessment). Of these participants, 209 older adults enrolled in the 23 programs in proximity to Greater Vancouver also consented to a more comprehensive assessment (comprehensive subset).

Following cessation of the 6-month intervention we invited 406 (89%) participants to complete a follow-up assessment between June 2017 and May 2018 -- approximately 12 months after completing their 6-month assessment (Figure 2). We did not invite those participants who had dropped out of CTM (n=50) or withdrawn from the evaluation (n=2). We obtained consent from 238 (52%) of the baseline cohort (60-74 years, n=168; ≥75 years, n=70).

Measurements

At 18-months we replicated previous measurement protocols [23]. We used data from 0, 6 and 18 months in this analysis. We provide a brief description of our measurement protocols below as they are described in greater detail elsewhere [23].

Province-wide assessment

At each time point, we collected survey-based data. Participants completed their surveys at group meetings (baseline) or at home (6, 18 months) via mailed surveys; participants who required extra assistance (3%) at 6 and 18 months completed the surveys over the phone with a trained research assistant. All participants completed a baseline demographic survey; items included age category, sex, self-reported height and weight, educational attainment, ethnicity, number of chronic conditions and self-rated health (single question [29, 30]). Participants self-reported PA (number of days/week >=30 minutes) using a valid and reliable single-item questionnaire [31, 32] and capacity for mobility as no/any difficulty walking 400 m and/or climbing one flight of stairs [33]. We assessed loneliness using a 3-item questionnaire (loneliness score; range 3-9 where higher scores indicate greater loneliness) that shows good internal consistency, discriminant validity and convergent validity [34] and social isolation using a 3-item questionnaire [35] adapted from two questions on social contact frequency [36] (social isolation score; range 0-15 where higher scores indicate less social isolation).

Comprehensive subset assessment

In addition to the measures described above, we assessed PA, mobility and muscle strength on a subset of participants at each time point using methods described in detail elsewhere [23]. Participants in the comprehensive subset completed their assessments at group meetings (baseline), dedicated measurement sessions (6, 18 months), or via mailed surveys (if they missed a group meeting or measurement session). We administered the CHAMPS questionnaire to assess PA (energy expenditure and frequency of moderate and all activities) [37]. Trained research assistants assessed mobility using the Short Physical Performance Battery (SPPB) [38] (summary score, range 0-12) and participants' muscle strength (grip strength, to the nearest 0.1 kg) using a handheld dynamometer (Jamar Plus, Patterson Medical).

Statistical Analysis

We performed all analyses using Stata v13.1 (StataCorp, College Station, TX USA). We first assessed whether participants with 18-month data differed from those who completed the intervention but did not return for follow-up. We used Chi-squared or Fisher's exact test for categorical variables (sex, age category, ethnicity, education, chronic conditions, mobility limitations, subset participation) and unpaired t-tests for continuous variables (BMI).

To address our objectives, we fit linear mixed effects models for each continuous variable (province-wide assessment: PA (single-item), social isolation, loneliness, mobility (self-reported); comprehensive subset: PA (CHAMPS), mobility (SPPB), muscle strength) with time (0, 6, 18 months) as a categorical predictor. We first fit an empty means random intercept model and tested whether random slopes improved model fit using likelihood ratio tests. In model 1 we included sex and age category as fixed effects. Model 2 included additional covariates: delivery partner, baseline mobility limitation (yes/no), number of chronic conditions (0, 1, $\geq$2), education, and BMI. In both models we added fixed effects sequentially and tested interactions with time after the addition of each fixed effect. With the exception of an age*time interaction, interactions were retained in the model only if the likelihood ratio test was significant ($p<0.05$). We assessed model fit graphically using residual plots. Adjusted values were calculated at each time point using the margins command in Stata with a Bonferroni adjustment to account for multiple comparisons between and within age groups. In the provincial cohort, we also used Chi-squared tests to assess differences in the proportion of participants with mobility limitations over time (6-18 months and 0-18 months) within each age group. We used a Bonferroni adjustment to account for multiple comparisons (significance at: 0.05/2 = 0.025).

RESULTS

Participants

Of 238 participants who consented to the follow-up evaluation, 3 participants withdrew or did not complete the evaluation. For analysis, we included all available data across three time points; the number of participants with data at 3, 2 and 1 time points was 235 (51%), 172 (38%) and 51 (11%), respectively. For those who returned for follow-up, baseline demographic characteristics, number of chronic conditions, mobility limitations and BMI were similar to those who did not return (Table 1). However, more participants who returned for follow-up rated their health as good or excellent for their age as compared with those who didn't return (59% vs 45%, p=0.04).

Province-wide Assessment

We present outcomes for the whole sample (province-wide assessment) in Table 2. As results were similar for models 1 and 2, we focus on the fully adjusted models (model 2) below.

Physical Activity

Objective 1 (6-18 months): In younger participants, PA decreased between 6 and 18 months (-0.5 days/week; 95% CI: -0.8, -0.1; p=0.007). In older participants, PA did not differ between 6 and 18 months.

Objective 2 (0-18 months): In younger participants, PA at 18 months was higher than at baseline (+0.9 days/week; 95% CI: 0.5, 1.3; p<0.001). In older participants PA at 18 months did not differ from baseline.

Mobility

Objective 1 (6-18 months): Among both age groups, prevalence of mobility limitations did not differ between 6 and 18 months (60-74 years: 31% vs. 34%, p=0.458; ≥75 years: 43% vs. 54%, p=0.155).

Objective 2 (0-18 months): Among both age groups, prevalence of mobility limitations did not differ between baseline and 18 months (60-74 years: 41% vs. 34%, p=0.149; ≥75 years: 50% vs. 54%, p=0.625).

Social Isolation

Objective 1 (6-18 months): In both younger and older participants, social isolation did not differ between 6 and 18 months.

Objective 2 (0-18 months): Among younger participants, social isolation score was higher (indicating lower social isolation) at 18 months compared with baseline (+0.7; 95% CI: 0.2, 1.1; p=0.001). Among older participants, social isolation score at 18 months was significantly lower (indicating greater social isolation) as compared with baseline (-0.7; 95% CI: -1.4, -0.05; p=0.033).

Loneliness

Objective 1 (6-18 months): Among younger and older participants, loneliness scores at 18 months did not differ compared to 6 months.

Objective 2 (0-18 months): Loneliness scores at 18 months were not significantly different from baseline values in either the younger or older participants.

Comprehensive Subset Assessment

We present outcomes for the comprehensive subset assessment in Table 3.

Physical Activity (CHAMPS)

Objective 1 (6-18 months): In younger participants, energy expenditure did not differ between 6 and 18 months. PA frequency (all activities and moderate activities) decreased significantly from 6 to 18 months in younger participants (-4.0; 95% CI: -6.6, -1.4; p=0.001). In

older participants, neither energy expenditure nor activity frequency differed between 6 and 18 months.

Objective 2 (0-18 months): In both younger and older participants, neither energy expenditure nor PA frequency (all activities and moderate activities) differed between 0 and 18 months.

Mobility (SPPB)

Objective 1 (6-18 months): For both age groups, SPPB scores did not differ between 6 and 18 months.

Objective 2 (0-18 months): Among younger participants, mobility at 18 months was significantly higher than at baseline (+0.5; 95% CI: 0.1, 1.0; p=0.003). Among older participants, mobility at 18-months did not differ significantly from baseline.

Muscle Strength

Objective 1 (6-18 months): For both age groups, muscle strength did not differ between 6 and 18 months.

Objective 2 (0-18 months): For both age groups, muscle strength did not differ between 0 and 18 months.

DISCUSSION

The literature related to scale-up of older adult PA interventions is sparse, particularly as it relates to maintenance of behaviour change. We extend this literature by 1) evaluating change in participant-level outcomes in the year following CTM—an effective 6-month scaled-up PA intervention [23] and 2) assessing maintenance of these same outcomes from baseline to 18-months (secondary objective). Twelve months after participating, those aged 60-74 years demonstrated

lower PA compared with PA levels at the *end of the* CTM *intervention*. However, they were **more** physically active at that final 18-month assessment than at the *start of the intervention*. Intervention-related benefits in social isolation, loneliness, mobility and muscle strength were maintained in this age group over time. In older participants (≥75 years), intervention-related benefits in loneliness and mobility were maintained in the 12 months following the intervention. When compared with baseline, PA levels in older participants were similar at 18 months whereas feelings of social isolation were slightly escalated. We discuss the implications of these findings below.

While actively participating in the 6-month intervention, PA among younger participants increased at 3 months and remained stable through a 3-month taper phase (fewer contacts with their activity coach) [23]. Our findings 12 months after CTM ended are meaningful given that all participants self-reported as low-active (<150 minutes/week of PA) when they started CTM. Increasing PA, especially from low levels, has public health benefits [39]. Maintaining even a light level of PA is associated with reduced risk of all-cause and cardiovascular mortality [40]. Increased PA (relative to baseline) in CTM participants aged 60-75 years counters the known age-related decline in PA and health [8, 9]. Among participants aged 75 years and older, PA returned to baseline levels during the 3-month taper phase [23] but PA did not decline further in the 12 months following CTM. In CTM participants, maintenance may indicate that older adults retained and applied learning and skills from CTM (e.g., goal setting, action planning).

The 6-month CTM intervention enhanced mobility (defined as any limitations walking or stair climbing) in younger participants and muscle strength in younger and older participants [23]. These benefits were maintained during the 12-month follow-up period, as was the intervention-related increase in mobility (by SPPB) in all participants. This finding highlights the importance

of continuous engagement in PA over time, to maintain functional capacity and reduce frailty [9, 41]. Importantly, low SPPB scores predict long term disability and/or institutionalization [42]. Given the close relationship between PA and mobility [9, 41], PA may have effectively countered common age-related declines in mobility [10]. However, we interpret results in the older age group with caution given the small sample size due to attrition, at follow up.

Intervention benefits related to social outcomes were maintained one-year post-intervention in both age groups with the exception of social isolation, which increased slightly in older participants when compared with baseline values. Loneliness is associated with deteriorating health including accelerated loss of physical functioning with age [43]. Similarly, the caring and respect that occurs with social connections and an associated sense of well-being, can protect against health problems [44]. Conversely, social isolation exacerbates negative health effects in older adults; these include increased risk for all- cause mortality [45] and dementia [46]. Participants' positive relationship with their activity coach and interactions with other participants influenced feelings of social connectedness during CTM [47, 48]. Sharing information and experiences, learning from their peers and engaging with others who share familiar experiences also contributed to feelings of social connection [35]. It seems imperative to maintain social and mental health benefits; to do so programs that support these outcomes must be ongoing. However, the amount or quality of interaction afforded through participation in CTM may have been insufficient to counter feelings of social isolation in our oldest participants.

Physical activity programs for older adults showed benefit at 12 (but not 24) months, based on a meta-analysis of mostly small scale trials [49]. Therefore, our study provides a novel contribution to scale-up science and adds important evidence with a study where an intervention

was implemented and evaluated, at scale [11, 15-19]. To improve population health, effective PA interventions for older adults must be scalable [50] and scaled-up [14].

Strengths and limitations

To date, most PA programs for older adults targeted clinical populations and were not translated from clinical trials into 'real world' settings or scaled-up. Our novel study assessed whether functional improvements that older adults accrued during a 6-month scaled-up intervention were maintained one year after the intervention ceased.

We acknowledge that our study had a number of limitations. First, although we retained a reasonable proportion of participants, those with poorer self-rated health were less likely to complete follow-up assessment; this is similar to previous studies [51]. Second, the pragmatic measures we used were reliable and valid, but were limited mostly to self-report. Third, our sample included a relatively small number of adults ≥75 years, which could limit our ability to convincingly detect maintenance or decline in health outcomes in this group. As older adults are at risk for increased social isolation [52] and diminished mobility, [10, 53] it seems important to target this population.

Implications of this work and future directions

The results we observed at follow-up raise at least two questions. First, what is the minimum dose of an intervention required to maintain short- and long-term impact? Second, can booster contacts effectively maintain PA behaviours and health benefits [54]? In addition, we call for more detailed studies that describe: the implementation process to identify best fit in (for example) different geographic, cultural and even clinical settings; how best to engage delivery partners in planning, scaling-up and sustaining an intervention; and how to adapt the intervention and implementation strategies to optimize cost-effectiveness while retaining health benefits.

Global health initiatives achieved scale-up success using a phased approach and integrating programs into functioning systems and services [55]. We opine that investing in long-term program success and utilizing health-promoting opportunities that exist in local environments, may maintain healthy behaviours and associated outcomes. An integrated approach to scale-up acknowledges levels of influence on behaviour change across a socioecological continuum that spans individual to systems-level influences [13]. It is time for a paradigm shift toward implementing studies that target scale-up of effective health promoting interventions for older adults—and even more so—to determine how to sustain programs that promote and maintain positive behaviours in future.

297 **Figure Captions**

298

299 **Figure 1.** The timing of program components and data collection for the present study. The
300 CTM program consisted of 4 Motivational Group Meetings, 1 one-on-one session with an
301 Activity Coach and 10 Check-ins (phone, email or in person).

302

303 **Figure 2.** Participant flow through the study. Participants in the comprehensive subset completed
304 more detailed assessments (physical activity, mobility and muscle strength) in addition to the
305 paper-based surveys completed by the provincial cohort.

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307

Acknowledgements

We thank our delivery partner organizations, facility managers and coordinators, activity coaches, and all the older adults who participated in Choose to Move. Thanks also to staff and trainees from AART (Centre for Hip Health and Mobility, University of British Columbia, Vancouver, Canada) for data collection. Study data were collected and managed using REDCap electronic data capture tools hosted at the University of British Columbia. REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies, providing: (1) an intuitive interface for validated data entry; (2) audit trails for tracking data manipulation and export procedures; (3) automated export procedures for seamless data downloads to common statistical packages; and (4) procedures for importing data from external sources.[56]

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